§9. Development of a High Power, 84GHz CW Gyrotron

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We have been developing 0.5 - 1MW, 84GHz CW gyrotrons for Large Helical Device (LHD). In this gyrotron, the electro-magnetic waves ($TE_{15,3}$ mode), excited in the resonator, are separated from a spent electron beam by a built-in mode converter which consists of a modified Vlasov-type launcher with a visor and beam shaping mirrors. The cold testing of the converter shows the sidelobe level of the converted Gaussian-like beam is below -25dB. The low beam loading can be realized on the large collector by this structure for pure CW operation.

We designed and constructed the second tube which had a build-in mode converter, using the successful design of the electron gun, the beam shaver, the collector and the window of the first tube. This structure allows to separate an output millimeter wave from an waveguide to reduce not only the effect of window miss-matching with an output load, but also the restriction of collector structure. Operational mode is changed from $TE_{15,2}$ to $TE_{15,3}$ to reduce the Ohmic loss in the cavity wall. The ratio of these cavity radii corresponds to 1.2, which lowered the heat loading in the cavity wall as low as $1kW/cm^2$. The output mode is converted from excited $TE_{15,3}$ mode in the cavity to a Gaussian-like beam.

The built-in mode converter system consists of a modified Vlasov launcher with a so-called visor and beam shaping mirrors. As shown in Fig. 1, this modified Vlasov launcher has a visor section on the location of the straight edge in conventional Vlasov one. The visor deforms the beam power profile to the Gaussian on the first mirror. The density of the wave beam energy becomes low at an edge of launcher to reduce a diffraction loss to 5-7%, comparing with 15-20% of a conventional Vlasov converter. The first mirror corrects the beam phase to generate a nearly parallel beam. The second mirror, which has an elliptic like shape, focuses the beam to couple to the output window of 4 inch's diameter. The converter was designed on the basis of the geometric optics[1].

The cold test was performed to examine the mode converter before it was assembled in the tube. We could apply the cavity mode generator[2] for the beam alignment testing in the final assembly of the actual tube.

Figure 2 shows the typical power contour plots of detected radiations at the location of the window position. Almost all the power can pass through the output window.

Now we have just begun the RF testing of this gyrotron. So far we have obtained over 300kW output in short pulse operation.

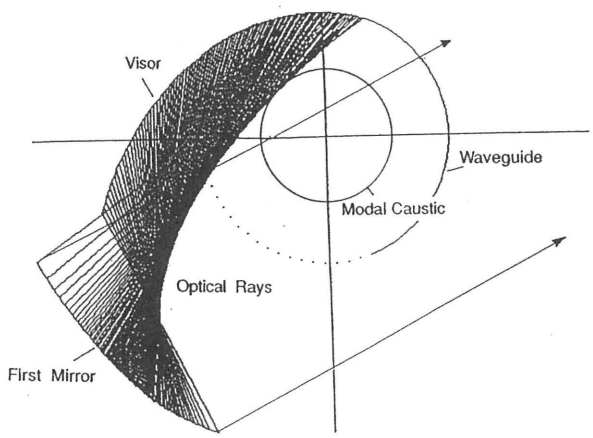

Fig.1. Design of a modified Vlasov converter with a visor and calculated quasi-optical rays.

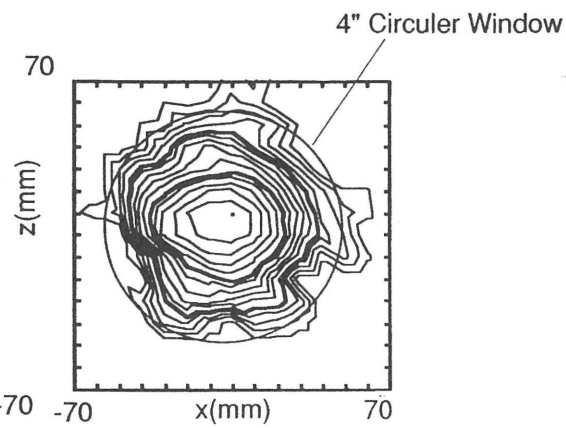

Fig.2. Measured radiation pattern at output window position.

References

1) M.Iima, M.Sato, et al.: Conf.Digest 14th Int. Conf. on Infrared and Millimeter Waves, Wurzburg, 1989, p.405.
2) N.L.Aleksandorov, et al.: Int. J. of Infrared and Millimeter Waves, 13(1992)1369.